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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/629,780	07/31/2000	Yowjuang W. Liu	5251	4875

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James P Hao Esq  
Wagner Murabito & Hao LLP  
2 North Market Street  
3rd Floor  
San Jose, CA 95113

EXAMINER

PIZARRO CRESPO, MARCOS D

ART UNIT	PAPER NUMBER
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2814

DATE MAILED: 04/10/2003

14

Please find below and/or attached an Office communication concerning this application or proceeding.

### Office Action Summary

Application No.

09/629,780

Applicant(s)

LIU ET AL.

Examiner

Marcos D. Pizarro-Crespo

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 19 February 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 16-35 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 16-35 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

#### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

#### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_ 6) ☐ Other: \_\_\_\_\_

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~~Attorney's Docket Number: 5251~~

Filing Date: 7/31/2000

Claimed Foreign Priority Date: none

Applicant(s): Liu et al.

Examiner: Marcos D. Pizarro-Crespo

### **DETAILED ACTION**

This Office action responds to the amendment in paper no. 13 filed on 2/19/2003.

#### ***Continued Examination Under 37 CFR 1.114***

1. A request for a continued examination under 37CFR1.114, including the fee set forth in 37CFR1.17e, was filed in this application after the final rejection in paper no. 10, mailed on 10/21/2003. Since this application is eligible for a continued examination under 37CFR1.114, and the fee set forth in 37 CFR 1.17e has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 2/19/2003 has been entered.

#### ***Acknowledgment***

2. The amendment in paper no. 13, filed on 2/19/2003, in response to the Office action in paper no. 10, mailed on 10/21/2003, has been entered. The present Office action is made with all the suggested amendments being fully considered. Accordingly, pending in this Office action are claims 16-35.

#### ***Claim Rejections - 35 USC § 112***

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

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4. Claims 19 and 28-35 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

5. Claim 19 recites that the step of forming the source/drain regions comprises "a self-limiting diffusion process". The description in the original disclosure (pp.13/II.19) describes a "corner-limiting diffusion process", but fails to support the self-limiting diffusion process recited in claim 19.

***Claim Rejections - 35 USC § 102***

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6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claims 16, 17, 21, 24, 25, and 27 are rejected under 35 U.S.C. 102(b) as being anticipated by Acovic (US 5315142).

8. Regarding claim 16, Acovic (see, e.g., figs. 2-12) shows all aspects of the instant invention including a method of fabricating a semiconductor device with a trench gate comprising:

- forming an oxide layer **215** on the surface of a semiconductor substrate **130**
- forming a nitride layer **210** on the oxide layer **215**
- etching a trench **45** having substantially upright vertical sidewalls and a bottom surface in the substrate **130**

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➤ ~~forming a trench to gate insulating layer inside the trench 45~~

- forming a trenched gate electrode **110** on the insulating layer
- forming source/drain regions **47, 50** in the substrate **130** such that the regions partially extend laterally underneath the bottom of the trench **45**
- forming an inter-gate dielectric layer **115** on a top surface of the trenched gate electrode **110**
- forming a control gate electrode **40** on a top surface of the inter-gate dielectric layer **115**

wherein the insulating layer comprises a trench gate dielectric spacer **100** formed on the upright vertical sidewalls inside the trench **45** and a trench gate tunneling dielectric **105** formed on the bottom surface inside the trench **45**.

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9. Regarding claim 17, Acovic shows the step of forming the trenched gate electrode further comprising the steps of:

- depositing a layer **110** of polysilicon on the insulating layer inside the trench **45** (see, e.g., fig. 10)
- planarizing the layer **110** of polysilicon to a substantially planar orientation with a top surface of the substrate **130** (see, e.g., fig. 11)

10. Regarding claim 21, Acovic shows that the nitride is silicon nitride (col.6/ll.14).

11. Regarding claim 24, Acovic shows the method further comprising a step of planarizing the trenched gate electrode using the nitride layer as a stop for the planarization process (col.6/ll.45-48).

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12. ~~Regarding claim 25, Acovic shows the method further comprising a step of~~  
removing the nitride layer using a plasma etch (col.6/ll.65-66).

13. Regarding claim 27, Acovic further shows that the trench may be 5000 Å deep (col.6/ll.22).

***Claim Rejections - 35 USC § 103***

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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15. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

16. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Lin (US 6127226) and Jaeger.

17. Regarding claim 18, Acovic shows most aspects of the instant invention (see paragraphs 8-13 above), except for a step of implanting the substrate to form sidewall dopings in the substrate that laterally space the source/drain regions from the trench.

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Lin, on the other hand, shows (see, e.g., fig. 5B) a step of implanting a semiconductor substrate 12 to form sidewall dopings 22 in the substrate 12 (see, e.g., fig. 9B). Moreover, Lin teaches that this step is a threshold implantation step (col.4/ll.65).

Along these lines, Jaeger (pp.178) teaches that threshold voltage is directly related to substrate doping and that there are several tradeoffs involved in the choice of substrate doping. According to Jaeger (pp.178), Lin's threshold implantation step is routinely used in the art to separate the threshold-voltage design from other factors involved in the choice of substrate doping.

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Consequently, it would have been obvious at the time of the invention to one of ordinary skill in the art to include in Acovic's method the step suggested by Lin of implanting the substrate to form sidewall dopings since, as taught by Jaeger, this step is routinely used in the art to separate threshold voltage design considerations from other factors involved in the choice of substrate doping.

18. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Lin, Jaeger and Wolf (US 3873371).

19. Regarding claim 20, see the comments stated above in paragraph 17 in regards to claim 18 and which are considered repeated here.

In addition, Lin shows that the sidewall dopings are ion implanted at an angle to assure that the substrate sidewalls are implanted at the right dosage (see, e.g., fig. 5B; col.4/ll.64-col.5/ll.3). Lin, however, fails to specify that the angle of implantation be between 15-57°. Angle differences, however, are considered obvious design choices

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and are not patentable unless unobvious or unexpected results are obtained from these changes.

Wolf (col.2/ll.10-14), for example, teaches that the angle of implantation is a design variable that, if properly chosen, allows controlling the location at which the implanted impurities are introduced into the semiconductor substrate.

Consequently, it would be an obvious matter of design choice to select a suitable angle to implant the sidewall dopings of Acovic/Lin/Jaeger, as taught by Wolf, since this angle is a variable of importance subject to routine experimentation and optimization and it is not inventive to discover the optimum or workable ranges by routine experimentation. *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235.

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20. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic.

21. Regarding claim 22, Acovic shows most aspects of the instant invention (see paragraphs 8-13 above). In addition, Acovic discloses that the nitride layer is approximately 1000 Å thick (col.6/ll.15), instead of 1500 Å thick, as recited in claim 22. Although the claimed thickness and the prior art thickness do not overlap, it has been held that a *prima facie* case of obviousness exists where the claimed and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. It appears that the differences in thickness between Acovic and the claimed invention produce no change in the properties of the nitride layer and therefore would have been obvious (*Titanium Metals Corp of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985)).



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22. ~~Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic~~  
in view of Moon (US 5719085).

23. Regarding claim 23, Acovic shows most aspects of the instant invention (see paragraphs 8-13 above). In addition, Acovic shows that the oxide layer is 400 Å thick (col.6/ll.13), instead of the claimed thickness of 100 Å. This oxide layer provides an etch stop for a subsequent silicon nitride removal step (col.6/ll.60-63). In a similar method, Moon (col.3/ll.62-col.4/ll.2) teaches the use of a 100-Å-thick oxide layer as an etch stop for the removal of silicon nitride. As suggested by Moon, it appears that the differences in thickness between Acovic and the claimed invention produce no change in the properties of the oxide layer and therefore would have been obvious (*Titanium*

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*Metals Corp of America v. Banner*, 778 F.ed 775, 227 USPQ 773 (Fed. Cir. 1985)).

24. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Sharma (US 5382540).

25. Regarding claim 26, Acovic shows most aspects of the instant invention (see paragraphs 8-13 above), except for a trench's width between 100-5000 Å. Acovic (col.6/ll.22), however, shows that the trench has a depth of approximately 5000 Å. As Sharma teaches (col.9/ll.20-30), it is important to choose the proper aspect ratio for Acovic's trench, i.e., the depth to width ratio, in order to facilitate its formation and to avoid voids within subsequently deposited layers.

Consequently, it would be an obvious matter of design choice to select an appropriate width for Acovic's trench, as taught by Sharma, since this width is a variable of importance subject to routine experimentation and optimization, and it is not inventive

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~~to discover the optimum or workable ranges by routine experimentation. *In re Aller*,~~  
220, F.2d 454, 105 USPQ 233, 235.

26. Claims 19, 28, 29, 32, 33, and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Kroger (US 4544937).

27. Regarding claim 19, Acovic shows (see, e.g., figs. 2-12) most aspects of the instant invention including a method for fabricating a semiconductor device with a trenched gate comprising:

- etching a trench **45** having substantially upright vertical sidewalls and a bottom surface in a semiconductor substrate **130**
- forming a trench-to-gate insulating layer inside the trench **45**
- forming a trenched gate electrode **110** on the insulating layer
- forming source and regions **47**, **50** in the substrate **130** such that the regions partially extend laterally underneath the bottom of the trench **45**
- forming an inter-gate dielectric layer **115** on a top surface of the trenched gate electrode **110**
- forming a control gate electrode **40** on a top surface of the inter-gate dielectric layer **115**

wherein the insulating layer comprises a trench gate dielectric spacer **100** formed on the upright vertical sidewalls inside the trench **45** and a trench gate tunneling dielectric **105** formed on the bottom surface inside the trench **45**.

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~~Acovic, however, fails to show the step of forming the source/drain regions~~  
comprising a self-limiting diffusion process. Acovic differently performs ion implantation to form the source/drain regions (col.7/ll.66-68).

Kroger, on the other hand, teaches that diffusion and ion-implantation processes are equivalent doping techniques, both well known in the art (col.6/ll.24-28). Moreover, a self-limiting diffusion process is one of the most widely used methods of introducing controlled amounts of impurities into a semiconductor substrate (col.6/ll.28-36).

Consequently, it would have been obvious at the time of the invention to one of ordinary skill in the art to substitute the ion-implantation step of Acovic by the self-limiting diffusion step suggested by Kroger in order to introduce controlled amounts of impurities into the substrate.

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28. Regarding claim 28, Acovic shows the method further comprising:

- forming an oxide layer **215** on the surface of the substrate **130**
- forming a nitride layer **210** on the oxide layer **215**

29. Regarding claim 29, Acovic shows the nitride is silicon nitride (col.6/ll.14).

30. Regarding claim 30, see the comments, which are considered repeated here, stated above in paragraph 21 in regards to claim 22.

31. Regarding claim 32, Acovic shows the method further comprising the step of planarizing the trenched gate electrode using the nitride layer as a stop for the planarization process (col.6/ll.45-48).

32. Regarding claim 33, Acovic shows the method further comprising the step of removing the nitride layer using a plasma etch (col.6/ll.65-66).

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33. ~~Regarding claim 35, Acovic shows that the trench may be 5000 Å deep~~  
(col.6/ll.22).

34. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Kroger and Moon.

35. Regarding claim 31, see the comments, which are considered repeated here, stated above in paragraph 23 in regards to claim 23.

36. Claims 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Kroger and Sharma.

37. Regarding claim 34, see the comments, which are considered repeated here, stated above in paragraph 25 in regards to claim 26.

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### ***Response to Arguments***

38. Applicant's arguments with respect to claims 16-35 have been considered but are moot in view of the new ground(s) of rejection.

### ***Conclusion***

39. Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Art Unit 2814 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2814 Fax Center number is **(703) 308-7722** or **-7724**. The Art Unit 2814 Fax Center is to be used only for papers related to Art Unit 2814 applications.

40. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Marcos D. Pizarro-Crespo** at **(703) 308-6558** and


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between the hours of 9:30 AM to 6:00 PM (Eastern Standard Time) Monday through Thursday or by e-mail via [Marcos.Pizarro@uspto.gov](mailto:Marcos.Pizarro@uspto.gov). If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy, can be reached on (703) 308-4918.

41. Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.

42. The following list is the Examiner's field of search for the present Office Action:

Field of Search	Date
U.S. Class / Subclass(es): 438/257-267, 257/314-326	3/26/2003
Other Documentation:	
Electronic Database(s): EAST (USPAT, EPO, JPO)	3/26/2003

  
LONG PHAM  
PRIMARY EXAMINER

**Marcos D. Pizarro-Crespo**  
Patent Examiner  
Art Unit 2814  
703-308-6558  
[marcos.pizarro@uspto.gov](mailto:marcos.pizarro@uspto.gov)